



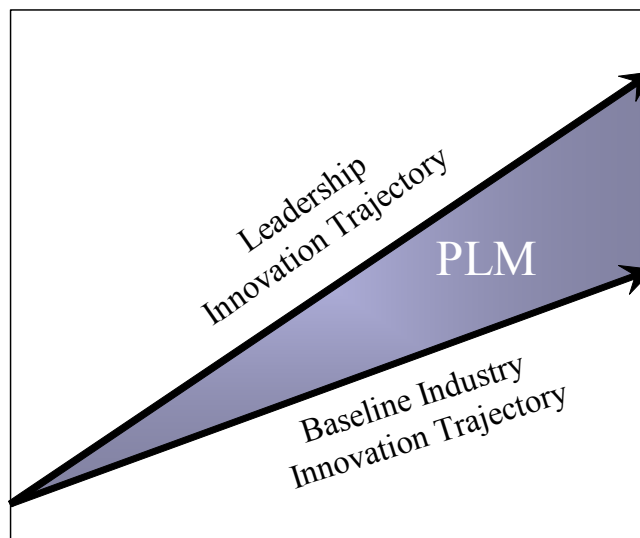
## PLM and Innovation – A Strategic Imperative or an Oxymoron

During the past several years, product development organizations have attempted to shift their strategic priorities from lowering product development costs and reducing cycle time (e.g. improving time-to-market), to finding ways to infuse greater innovation and differentiated features/capabilities into their products. The PLM technology vendors have likewise followed this trend by introducing products and services that support the desire for greater product innovation. But are companies really succeeding in delivering on the new “PLM Imperative” of innovation? Is top-line revenue growth accelerating for companies who purport to be following an innovation-centric PLM strategy? The evidence, while still anecdotal, suggests that very few companies are indeed succeeding in using PLM as an initiative to drive product innovation. One only has to look at the anemic top-line revenue growth rates, and the limited numbers of successful user testimonial cases to understand that innovation-centric PLM is little more than an ephemeral wisp for most companies. This begs the question, “Can PLM truly deliver on the promise of greater product innovation or is this simply a marketing slogan”? At Collaborative Visions, we believe that PLM can indeed deliver on the promise of greater product innovation, but it requires two fundamental changes:

1. Recasting the PLM mission to place greater focus on the *innovation* process versus the *productization* process by raising the *Product Innovation Trajectory*
2. Extending PLM technologies to include *innovation-centric tools and capabilities* which help to infuse more innovation and product differentiation.

**Figure 1**  
**Product Innovation Trajectory**

Product Innovation



Time

The PLM Mission: Raising the Product Development Innovation Trajectory  
Historically, the mission of product development organizations has been centered on the idea of lowering product development costs (productivity) and increasing the speed of product development (time-to-market). CAD and PDM tools have greatly assisted companies to improve the mission in each of these areas. Today however, the world has moved beyond cutting costs and throughput speed as mechanisms for gaining significant competitive advantage. Indeed, most industries have reached competitive parity with respect to how efficiently and how fast, products are developed. The new competitive battleground has clearly shifted towards making more innovative, highly differentiated products – products which can dramatically grow market share and increase top-line revenues. This battleground requires recasting the fundamental mission of product development organizations to finding ways to organically raise the *Product Development Innovation Trajectory* as illustrated in Figure 1.

*“The fundamental mission underlying an innovation-centric PLM strategy is to raise the trajectory of product innovation to in order to consistently develop and deliver more highly differentiated products that get customers excited about buying”*

Within any given industry, there is an underlying pace of innovation or *Baseline Innovation Trajectory* at work. For example, the microprocessor industry follows Moore’s Law which states that price/performance of microprocessors doubles every 18 months. To be competitive therefore, companies must adopt product development strategies which allows them at a minimum to keep pace with this rate of innovation. For most companies however, merely keeping pace with the Baseline Innovation Trajectory is not a strategy that will lead to higher levels of product revenue growth. Unless the company is the dominant player in a given market (e.g. Intel in microprocessors, Microsoft in PC office software), the odds are low that a company can achieve significant and durable competitive advantage by merely “keeping up with the Jones’s” in the race to innovate. Winning on a consistent basis in the game of innovation requires that companies adopt a *Leadership Innovation Trajectory* -- a trajectory which creates a sufficient degree of separation between itself and its competitors. Simply stated, the fundamental mission of an innovation-centric PLM strategy is to raise the trajectory of product innovation in order to consistently develop and deliver more highly differentiated products that get customers excited about buying

Leadership Innovation Trajectory =  $C^2V^2$

When examining the great product innovation leaders such as 3M, BMW, General Electric, IBM, Pfizer, and Sony, what sets these companies apart with respect to their consistent introduction of innovative products and services is their mastery of the Leadership Innovation Trajectory formula which involves the four fundamental imperatives of culture, creativity, visibility and velocity, or  $C^2V^2$  for short. While PLM technology plays a major role in helping these leaders achieve leadership, their ability to exploit the technology advantages of PLM is greatly enhanced over its competitors because they are better equipped to leverage PLM as a tool for innovation. In other

words, their adherence to the Leadership Innovation Trajectory formula provides the foundation from which they are able to maximize the return on innovation with respect to PLM technologies.

### **Culture – Forging the Crusade to Innovate**

There is little doubt that most product development executives would agree with the obvious need to raise the innovation trajectory in order to outpace its competition. However, in practice, this is often very difficult to achieve due to the enormous institutional and cultural inertia that works against the agents of change that are required. The overly bureaucratic nature of many product development processes, the lack of visionary, risk-taking leadership, and the difficulty of changing the status quo are key inhibitors in accelerating innovation. All of the best PLM technology in the world will not make a scintilla of difference if the product development organization is not galvanized and energized around the cause of innovation. Enlightened product development organizations don't think of product development as a process as much as they do a crusade. In all cases, the innovation crusade is led by an energetic and charismatic leader who has the ability to inspire. These leaders live, eat and breathe innovation and are enthusiastic champions of risk-taking ideas versus the safety and comfort of status quo incremental improvement. They also have a nearly insatiable zeal to transform this Zen-like energy to the organization. A great example of this enlightened leadership can be found at renowned innovator IDEO in Palo Alto, California led by Dave and Tom Kelley who churn out more innovation per capita than any other company in the world. While IDEO's no bureaucracy, job title-less, group think, all for one - one for all model may not scale to the level of an automotive or aerospace company, the characteristic of enlightened, energetic leadership is absolutely transferable. The ability to lead, and not just to manage is a skill that is sorely lacking in many product development organizations and is one of the primary reasons why many PLM innovation initiatives often fall well short of their targets.

A good litmus test to know whether or not a product development organization has been culturally conditioned to innovate is to walk around the engineering department an hour or two after the normal quitting time. If you do this at companies like Sony and 3M, you will still see lots of people still working. Why, because they have to? No, it's because they want to. These people don't want to quit, and often work incredibly long, Edison-like, hours, because to them, innovation is a labor of love. It's what drives them, and ultimately what drives the engine of innovation at these companies.

**Creativity – Pursuing Higher Levels of Innovation**

“Innovate or Die” is a common mantra espoused by companies who rightly understand that innovation is the key to building a winning product development strategy. However it is important to target the right classes of innovation (See Figure 2).

**Figure 2  
Classes of Innovation**

Innovation Matrix

Creativity	“Category Killer” Innovation	Paradigm-Shifting Innovation
	<ul style="list-style-type: none"> <li>• Optimal use of Intellectual Assets</li> <li>• Maximize product brand differentiation</li> <li>• Innovate to create “Category Killer” products</li> </ul>	<ul style="list-style-type: none"> <li>• Optimal synthesis of Intellectual and Information Assets</li> <li>• Maximize new product introduction</li> <li>• Innovate to create new market opportunities</li> </ul>
	Linear Innovation	Customer-Driven Innovation
	<ul style="list-style-type: none"> <li>• Optimal use of Capital Assets</li> <li>• Design for quality and cost</li> <li>• Innovate to drive costs down and add small functional improvements</li> </ul>	<ul style="list-style-type: none"> <li>• Optimal use of Information Assets</li> <li>• Design for rapid re-use and product reformulation</li> <li>• Innovate to expand customer opportunities</li> </ul>
	Agility	

Most product development programs and dollars are overly weighted towards small, incremental innovations (Linear Innovation). Numerous studies on the leading corporate innovators (e.g. Sony, 3M, and Nokia) have shown that these companies take greater risks and target more of their product development resources towards higher degrees of innovation. There are four classes of product innovation that vary based the degree of organizational agility and innovation creativity:

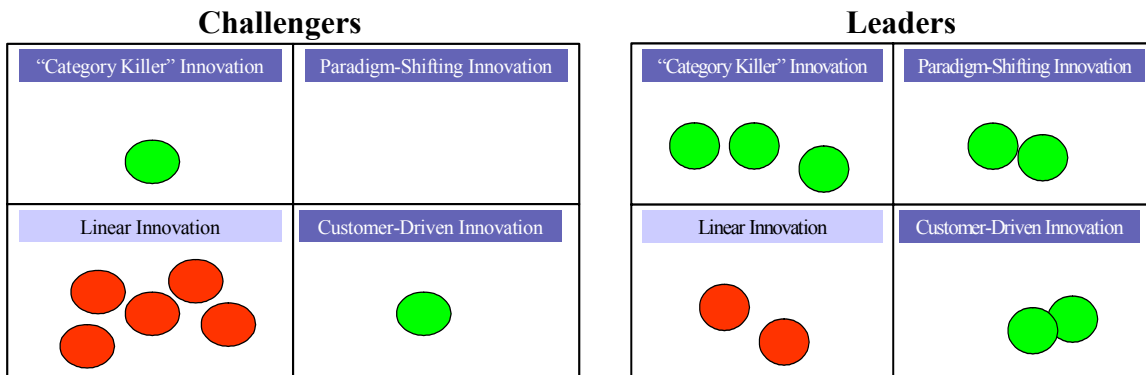
**Linear Innovation** is the ability to develop and introduce standard products or product family additions that meet or exceed the industry average cycle-time and incorporate innovations that follow the industry’s standard technology curve (e.g. the Baseline Innovation Trajectory) This is a “keeping up with the Jones’s” strategy and generally does not produce durable returns, nor does it require an innovation-centric PLM strategy.

**Customer Driven Innovation** dynamically recombines, modifies, or tailors parts and assemblies into new or custom products based on customer demands (example: personal computers, bicycles, athletic shoes). This is the fastest growing class of innovation enhanced by the use of web portal technologies to assist customers in specifying and designing their own products. Under this scenario, the PLM system essentially becomes the Order Management system.

**Category Killer Innovation** is the ability to maintain or extend brand leadership in an existing well defined commodity product category (e.g. HP in printers, Nokia in cell phones). Leadership here requires staying ahead of the competition by offering greater price performance.

**Paradigm-Shifting Innovation** is the ability to develop and introduce breakthrough products that appeal to entirely new user markets or dramatically expand existing market opportunities (examples: Chrysler Mini-Van, Sony PlayStation)

**Figure 3  
Innovation Products Portfolio Maps**



When the product portfolios of leaders versus challengers are mapped against these four classes of innovation (see Figure 3), the results are as follows:

- Leaders have 50% or more of its product development programs targeted at non-linear classes of innovation (e.g. Customer Driven, Category Killer and Paradigm Shifting).
- Challengers have 80% or more of its product development programs targeted at linear innovation
- It takes on average 3000 raw ideas to lead to one product success in the Customer Driven, Category Killer and Paradigm Shifting categories
- Leading innovators generate twice the number of raw ideas, three times the number of new products and enjoy a product success rate that is twice as high as challengers

All of the PLM technology in the world simply will not matter if companies are not targeting its use to achieve higher classes of innovation.

### **Visibility – Sharing and Leveraging Corporate Innovation Capital**

The innovation know-how of a company is embodied by the skills and knowledge of its people and by the accumulated knowledge and ideation data that led to the creation of product designs. Collectively, this rich reservoir of information forms the basis of a company's Innovation Capital assets. While companies have spent years and millions of dollars building asset management systems for financial and capital equipment assets, few have treated their Innovation Capital assets with the same strategic zeal. Of the major corporate assets that exist in a product oriented company, none is more important than their accumulated wisdom and know-how. Yet these knowledge assets are so dispersed among many systems and organization boundaries that it becomes very difficult for companies to access and leverage the many potential breakthrough ideas that are embodied in their own reservoir of Innovation Capital. Some industries however, particularly in the pharmaceutical area, treat their Innovation Capital as a real strategic weapon and have system philosophies which reflect this thinking. Pfizer scientists and technicians for example, routinely mine data from older clinical trials and laboratory tests within their Innovation Capital Asset Management systems, and apply this historical knowledge to create new breakthrough drugs.

To harness and leverage the collective Innovation Capital of the corporation, companies must:

1. Capture the knowledge and ideation data that led to the creation of a product design, not just the physical design description. For every CAD model created for example, there are:

- 1 to 5 analysis/calculation programs employed
- 5 to 10 collaborative engagements
- 10 to 15 governing engineering principles involved
- 15 to 20 related constraints and design goals
- 20 to 25 manufacturing related considerations
- 50 to 100 ideas considered

This data must be captured and made universally accessible. The vision of PLM must be extended beyond simply managing CAD data files and allow for the capture, reuse, and extension of knowledge.

2. Provide seamless mechanisms for tapping the knowledge and ideas of people within a domain expertise community regardless of organizational boundaries including:

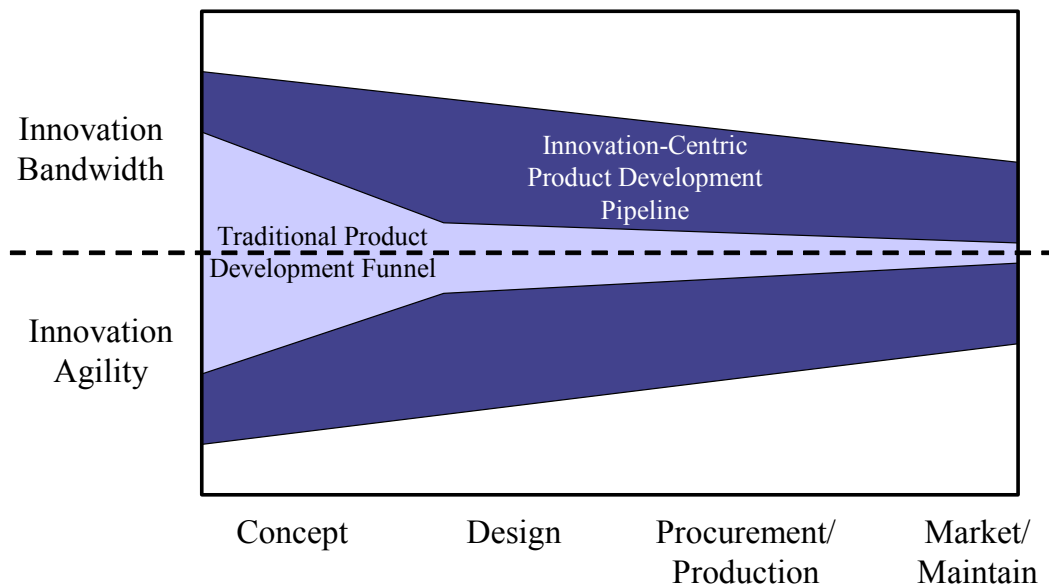
- Domain experts
- Interest communities
- Supplier relationships
- Customer relationships

Sony for example has an internal web-based "Innovation Community" organized by domain areas (e.g. optics, graphics, audio, etc.) where knowledge workers actively post and comment on ideas and design problems across organizational boundaries.

### Velocity – Rapidly Transforming Innovative Ideas into Winning Products

The innovation processes (not to be confused with the product development processes) inside most companies are often a major inhibitor to raising the Product Innovation Trajectory. Many companies still rely heavily on autocratic, front-ended, product committees (often referred to as the “product prevention committees”) for the vast majority of its innovation wisdom. In most cases when these committees produce a product specification, it is usually cast in stone, creating in effect a narrow innovation funnel (see Figure 4). Downstream engineers and designers are usually discouraged to deviate from the spec, even in cases where the product can be improved. When new ideas or approaches are discovered, it usually requires postponing their implementation until the next successive product cycle. This is a huge inhibitor to innovation since real product innovation occurs in often unpredictable ways and at unpredictable times throughout the entire product lifecycle. As many as 30% to 40% of the winning innovative ideas are often uncovered during the physical design process.

**Figure 4**  
**Product Development Funnel versus an Innovation Pipeline**



Leading innovators have a far different approach with respect to their innovation processes since they view it as more of a free-flowing pipeline versus a constricted funnel. They strive to enhance innovation during development cycles by increasing *Innovation Bandwidth* (the volume of ideas considered) and *Innovation Agility* (the speed and ease of incorporating new ideas). While there are still product committees inside these companies, the product specs they produce are cast in “wet cement” which allows downstream innovators to incorporate new innovations mid-stream, during the physical design process and at other points further out in the product lifecycle. The velocity that is most important to leading innovators is not raw, end-to-end throughput speed (e.g. design to first customer ship cycle time), it is the speed and agility of making course corrections

to incorporate new ideas at any point across the product development lifecycle. They do not wait for new revision or product development program cycles in order to incorporate great ideas.

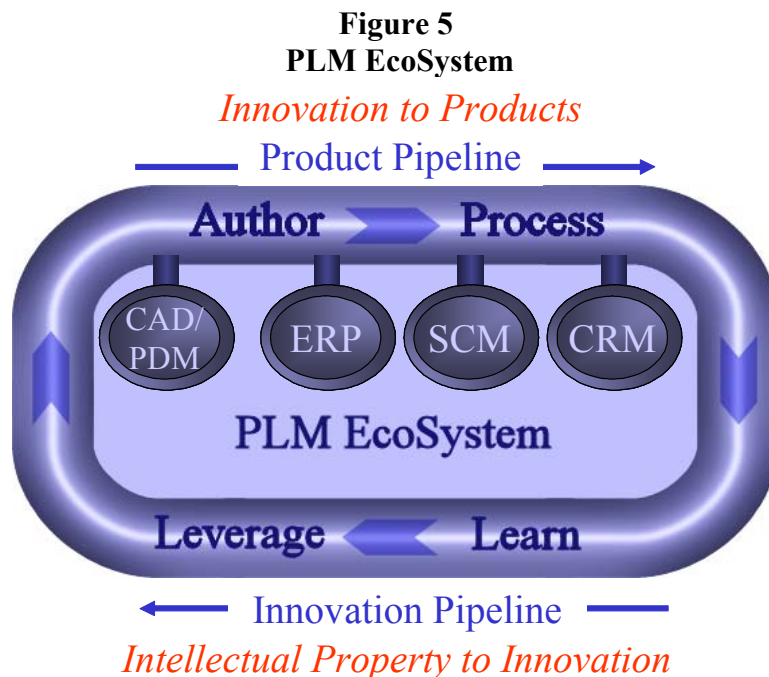
## Innovation-Centric PLM Technologies: Building the Innovation Pipeline

The role of technology is a vital component to implementing an effective innovation-centric PLM strategy. While most of the critical technologies necessary to support an Innovation-Centric PLM strategy are already developed, their deployment and use is still very limited due to two reasons:

1. The process framework in product development organizations is still heavily focused and weighted around engineering the physical product form and fit and under-weights the importance of developing breakthrough ideas which lead to more competitive functional characteristics and greater product innovation.
2. The cultural inertia and center of gravity in product development organizations still centers around older, traditional CAD and PDM technologies.

### The Product Lifecycle Process is Different than the Innovation Lifecycle Process

One of the major disconnects involving innovation-centric PLM, is the energy and attention given to the words “Product Lifecycle” which has come to mean expanding the view of product development beyond the boundaries of the engineering organization, encompassing everything from product concept through product retirement. This view is entirely appropriate when thinking about processes solely in terms of physical products but needs to be expanded when thinking about the broader lifecycle of intellectual capital that was used to create and engineer products.



A more appropriate metaphor and model for an idealized PLM approach which marries physical product development and innovation, is to think about it as an EcoSystem (see Figure 5). In this model, the *Product Pipeline* represents transforming innovation into products. Here, products are authored in CAD systems under PDM control and processed into physical form. Along the way, the physical design needs to interact with other business systems such as ERP, SCM and CRM. For the most part, companies are doing a good job in this area and have mature, well developed technologies (e.g. CAD, PDM) and processes in place to support the efficient development of physical products.

The part of the EcoSystem that is broken or nonexistent is the *Innovation Pipeline*. The Innovation Pipeline represents the universe of intellectual capital, knowledge, and ideas that provide the basis for creating innovation. Here, the Innovation Pipeline captures everything from customer experiences, and the innovation capital that is thrown off from the Product Pipeline (learning), and allows knowledge workers to do a deep dive into this information with tools and capabilities to explore, experiment, and ultimately leverage this into new innovation. It essentially is an intellectual “sandbox” which serves as a collection bin for innovation capital and provides the tools to transform this into new innovation-rich products. To achieve greater innovation throughout the PLM Ecosystem, a company must build the Innovation Pipeline as an explicit element of the overall PLM strategy.

### **Innovation Workbench**

Innovation with respect to product development is essentially the marriage of imagination and physics. We believe, as do most users, that the physics part of the innovation formula has largely been solved by the use of CAD and PDM tools. The imagination part however is still not well development in terms of a holistic system approach. What we believe is necessary is the creation of an Innovation Workbench system that would contain the following features and characteristics:

1. IP Asset Management – The collection bin for aggregating innovation capital assets and providing rich semantic indexing for mining innovation data
2. Opportunity Management – Opportunity assessment and idea generation tools
3. Innovation Engineering – Patent searching and problem solving engine
4. Imagineering – Soft prototyping tools used to explore and experiment with new ideas
5. Knowledge Fusion – Tools for creating smart applications which leverage knowledge assets and allow new ideas and designs to be morphed from historical design data.
6. Innovation Management – A virtual “war room” like environment for managing the innovation process

The Innovation Workbench would serve as a major companion system to existing PLM systems (CAD, PDM). Essentially, the Innovation Workbench would become the “CAD System for ideas”.

While most of the fundamental technology needed to support the vision of an Innovation Workbench is already developed, it has not been architected into a unified system as the one outlined. We believe however, there will be significant progress on this front during the next several years as there is a large market opportunity for new and existing PLM vendors to capitalize. In the meantime, users can begin to incorporate many of Innovation Workbench components by working with the best of breed vendors in each of these areas.

#### Bottom Line:

PLM technologies in their current form and process re-engineering efforts alone are insufficient in order to raise the Product Innovation Trajectory and drive top-line revenue growth. However, using PLM as an initiative to enhance and accelerate innovation is a realizable goal provided that users:

1. Reorganize the PLM strategic mission around the  $C^2V^2$  innovation imperatives of cultural transformation, pursuing higher classes of innovation, sharing and leveraging innovation capital, and focusing on the speed and agility required to infuse more innovation throughout the product lifecycle.
2. Recasting the PLM process framework from a product-centric lifecycle approach to a more comprehensive closed-loop ecosystem that encompasses the product pipeline as well as the innovation pipeline.
3. Incorporate “Innovation Workbench” technologies that work in conjunction with traditional CAD and PDM technologies to leverage the potential breakthrough ideas and knowledge that lead to greater and more sustainable innovation.